Physical and Numerical Analysis of Extrusion Process for Production of Bimetal Tubes

Benefits

This project will develop a science-based model that will enable a better understanding of how metals flow during coextrusion so that tooling designs and control process parameters can be optimized to obtain a quality product. This will enable industries to avoid the significant errorts associated with the trial-and-error methods currently pursued.

Applications

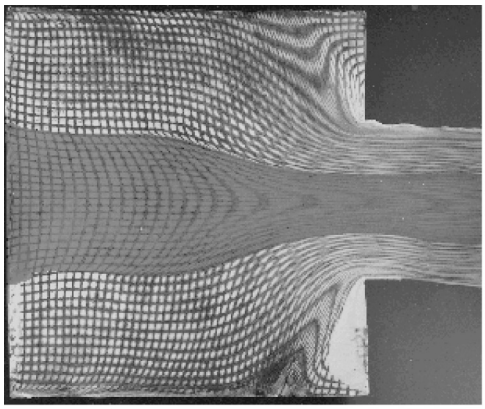
This project would offer benefits and savings for many applications, across many industries, including the following:

- **Chemical and Petrochemical:** Composite tubes & pipes in the ethylene cracking process.
- **Forest Products:** Composite tubes & pipes for transfer lines in kraft and biomass gasification systems.
- **Metalcasting:** Composite tubes & pipes in die casting (extend die life).
- **Steel:** Tubes and pipes in basic oxygen furnace (BOF) steel processing.

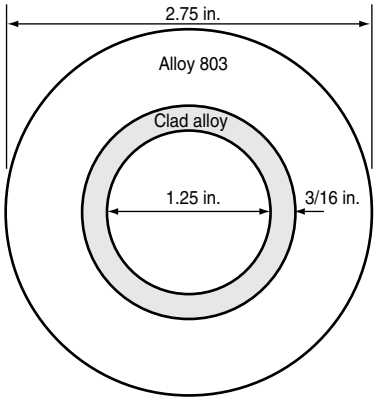
This project will develop numerical tools for modeling extrusion of bimetal tubes.

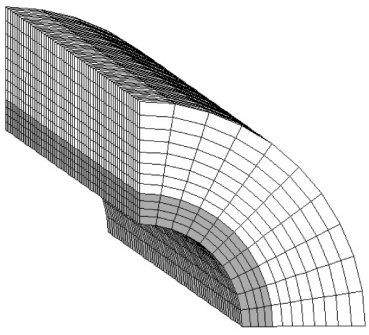
The proposed research will lead to the development of numerical design tools, that will incorporate metal properties and final tube geometry as well as tooling design, billet geometry, and selection of the extrusion process parameters. This approach will provide optimization improvements in geometrical tolerances and reductions in materials/product scrap.

Material flow during extrusion of bimaterial rod



Tube cross section geometry





Finite element mesh of tube

Project Description

Goal: The primary project objective is to understand and control metal flow in the coextrusion of bimetal tubes.

Issue: Even the largest metallurgical companies in the United States are not able to dedicate the resources necessary to study such complex phenomena as design and development of numerical tools for modeling of extrusion of bimetal tubes, and current trial-and-error methods are costly.

Approach: Two metals will be selected based on their service properties, such as corrosion resistance, elevated-temperature performance, strength, ductility, and surface finish. Process parameters such as temperature, ram speed, extrusion ratio, and lubrication on both container and mandrel interfaces with the extruded billet, will be included in the final model. One objective of this newly developed numerical model will be to indicate a selection of extrusion press characteristics (e.g., press capacity, container size) based on the required bimetal tube specifications.

Potential payoff: The successful development and implementation of this science-based technology will enable material producers to evaluate candidate coextruded materials before having to place them into production processes. Consequently, the life expectancy of selected bimetallic materials can be predicted, so that unexpected shut-downs can be avoided. This translates into elimination of unexpected downtime, and the extensive energy costs associated with these shutdowns (e.g., the material/product losses, material recycling costs, and the associated production/manufacturing process energy losses).

Progress and Milestones

- Develop basic process model.
- Develop module to address use of powder metals for tubes.
- Verify model using pilot scale bimetal tubes.
- Implement into industrial practice.

Primary

Lehigh University
Bethlehem, PA

Project Partners

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Dublin, OH

Dynamet Technology
Burlington, MA

The Energy Industries of Ohio
Cleveland, OH

Oak Ridge National Laboratory (ORNL)
Oak Ridge, TN

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January 2002

ORNL 2002-01483/chj